END CLOSURE ASSEMBLY FOR A PRESSURE VESSEL

This application is a continuation of U. S. Application Serial No. 10/411,959, filed on April 11, 2003.

FIELD OF THE INVENTION

The present invention relates to pressure vessels, and more particularly the present invention relates to an end closure assembly for a pressure vessel.

DESCRIPTION OF THE RELATED ART

Pressure vessels are used for a variety of industrial applications, particularly in filtration applications, such as direct or dead end filtration, cross flow filtration, hyperfiltration, etc. In one pressure vessel type, one or more end closure assemblies are installed in a pressure vessel and provide full-bore access to the pressure vessel. Such full-bore access allows filter material having a defined exterior diameter just less than that of the interior bore of the pressure vessel to be slidably inserted through an open end. Many various embodiments of pressure vessels and end closure assemblies are known. However, there continues to be sought an end closure assembly with certain features, such as improved resistance to corrosion, a more user-friendly releasing mechanism, and the like.

BRIEF SUMMARY OF THE INVENTION

In accordance with one aspect, the present invention provides an end closure assembly for a pressure vessel. The end closure assembly includes a non-metal universal head member positioned in an opening in the pressure vessel, wherein the universal head member has a size complementary to the opening in the pressure vessel, a retainer ring member engaged with the pressure vessel for retaining the universal head member in the opening in the pressure vessel, and a securing plate member engaged with the retainer ring member for securing the retainer ring member.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional side view of an example end closure assembly in a pressure vessel according to the present invention;

Figure 2 is a pictorial view of an example universal head of the assembly shown in Figure 1;

Figure 3 is a pictorial view of an example securing plate of the assembly shown in Figure 1;

Figure 4 is a pictorial view of an example elliptical head of the assembly shown in Figure 1;

Figure 5A is a plan view of an example of a retainer ring of the assembly shown in Figure 1;

Figure 5B is a side view of the retainer ring shown in Figure 5A; and

Figure 6 is a pictorial view of another example of a universal head of the assembly shown in Figure 1.

DESCRIPTION OF EXAMPLE EMBODIMENTS OF THE INVENTION

An example embodiment of an end closure assembly 10 for a pressure vessel, in accordance with the present invention, is illustrated in Figure 1. Pressure vessels are useful in, *inter alia*, pressure filtration applications using filter bags, filter cartridges, and the like. The pressure vessel (only partially shown) has an elongated tubular shell 12 that has at least one open end. The end closure assembly 10 is positioned at the open end so as to seal the pressure vessel, and thereby permits the pressure vessel to maintain elevated pressure levels therein. Such elevated pressure levels may be useful in filtration applications and the like.

Extending from the open end of the tubular shell 12, the shown example of the pressure vessel has a bell-shaped portion 20 that tapers outward and has a greater diameter than the diameter of the tubular shell 12. Fashioned in the interior of the bell-shaped portion 20 is a groove-like annular depression 25. At least one component of the end closure assembly 10 interacts with and engages the bell-shaped portion 20 at the annular depression 25. The annular depression 25 may be a carved-out section of the bell-shaped portion 20 and may have a separate element installed therein, such as a lining ring, or other suitable construction. The annular depression 25 and/or bell-shaped portion 20 may further include one or more grooves or other suitable annular element to provide for additional sites of interaction between the end closure assembly 10 and the bell-shaped portion 20.

The tubular shell 12 may be made of any material that has sufficient properties to withstand the pressure parameters of the pressure vessel. For

example, the tubular shell 12 may be made of a suitable metal alloy, preferably a corrosion-resistant alloy, a composite, a plastic, or the like. It is to be appreciated that a number of other suitable configurations of the tubular shell 12, bell-shaped portion 20 and annual depression 25 are possible and that the present invention is not intended to be limited by the embodiments thereof described herein.

With reference to Figure 1, the end closure assembly 10 includes a universal head 40, a securing plate 80 and a retainer ring 100. With reference to Figure 2, the universal head 40 is a unitary construction characterized by two elements: a domed-shaped element 41 and a tubular element 42. The domed-shaped element 41 has an inner surface 43 and an outer surface 44. Please note that the terms "inner" and "outer" are with reference to the containment provided by the pressure vessel. As such, when the end closure assembly 10 is positioned in the tubular shell 12, the inner surface 43 of the domed-shaped element 41 faces into the tubular shell 12. The domed-shaped element 41 has a parabolic design with a farthest extent of the domed-shaped element 41 into the shell 12 being at an apex 45 of the parabola. The inner surface 43 of the domed-shaped element 41 gradually tapers from the apex 45 to the shell 12. The outer surface 44 of the domed-shaped element 41 is similarly curved and faces outward and away from the pressure vessel. Further, the domed-shaped element 41 is provided with a flange-like member 50 that may interact with the retaining ring 100 or an elliptical head 60.

The tubular element 42 has an inner portion 46 and an outer portion 47. The inner portion 46 of the tubular element 42 extends, within the

shell 12, from the inner surface 43 at the apex 45 of the domed shaped element 41. The outer portion 47 extends from the outer surface 44 at the apex 45 of the domed-shaped element 41 and may have an externally threaded portion 49. In an alternative embodiment, as shown in Figure 6, the tubular element 42 may be provided without the threaded portion 49. The tubular element 42 further includes a hollow passageway 48 that extends axially therethrough and terminates at openings at each end of the tubular element 42. The hollow passageway 48 provides a conduit for liquid or gas, etc., flow centrally through the end closure assembly 10. Suitable additional components and/or structure (e.g., valves, etc.) are provided to control, use, etc., this conduit. Accordingly, the tubular element (e.g., at the outer portion 47 of the tubular element 42) may be provided with appropriate fittings, such as pipe threads and the like, to facilitate, control, use, etc., and interact with such additional structure.

The universal head 40 has a non-metal composition. According to one embodiment of the present invention, the universal head 40 is made of a plastic material. The plastic may be any suitable plastic capable of operating at elevated pressure levels. Examples of such suitable plastics include, but are not limited to, GE NORYL GFN3. The use of plastic may be advantageous in certain situations, such as when corrosion resistance is desired. Further, the use of plastic may be advantageous for lower pressure applications. However, it is to be understood that the present invention is not limited to a plastic universal head and that the universal head 40 may be made from any suitable material. For example, the non-metal composition may be a composite.

The end closure assembly 10 may further include an elliptical head 60. With reference to Figure 4, the elliptical head 60 is generally similar in shape and may be complementary in shape to the domed-shaped element 41 of the universal head 40. The elliptical head has a convex inner surface 61 that, when installed with the end closure assembly 10, lies near and may abut the outer surface 44 of the domed-shaped element 41. The elliptical head 60 has a curved outer surface 62 and a central opening 63 at its apex that is positioned concentric with the axial centerline of the bore of the tubular shell 12. The central opening 63 provides an opening through which the tubular element 42 of the universal head 40 protrudes. The elliptical head 60 may further include an annular lip-like ring 64 at an end most distal to the apex of the elliptical head 60. When the elliptical head 60 is coupled with the universal head 40, the lip-like ring 64 lies near and may abut the end 60 of the domed-shaped element 61, as shown in Figure 1. It is to be understood that the elliptical head 60 is an optional component and may or may not be included with the end closure assembly.

As shown in Figures 1 and 3, the end closure assembly 10 further includes a securing plate 80. The securing plate includes an inwardly extending tubular boss 81 and a plurality of stiffening elements 82 arranged in a spoke-like manner around the boss 81. The tubular boss 81 has an internally-threaded portion 83 that interacts with the externally threaded portion 49 of the tubular element 42.

The end closure assembly 10 further includes an annular retainer ring 100 (Figure 5A). The retainer ring 100 is made of at least two arced elements that are movable relative to each other and thereby facilitate its

insertion for use. The elements may be provided with sufficient structure to enable their interlocking. In the shown example, the retainer ring is made of three substantially identical arced interlocking elements 105A, 105B and 105C. It is contemplated that each of the three interlocking elements may be characterized by an identical shape. As shown in Figure 5B, the retainer ring 100 has two concentric portions, a radial inner portion 110 and a radial outer portion 115. The outer portion 115 has a greater outer diameter than the outer diameter of the inner portion 110. When the end closure assembly 10 is assembled, the inner portion 110 of the retainer ring 100 engages the annular lip-like ring 64 of the elliptical head 60 or atop the end 60 of the domed-shaped element 41, depending on whether an elliptical head is used, as shown in Figure 1. Because of the different diameters, the outer portion 115 effectively has an annular flange 120. The annular flange 120 fits within the annular depression 25 of the bell shaped portion 20 of the elongated tubular shell 12. Also, the securing plate 80 holds the outer portion 115 of the retainer ring 100 in the annular depression 25. The fitting and holding in the annular depression provides a locking mechanism, whereby the end closure assembly 10 is retained within the tubular shell 12 and is able to withstand elevated pressure levels in the pressure vessel. The retainer ring 100 may be made from any suitable material such as plastic or metal, such as stainless steel, and the like.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.